

Abstract

Translational Cellular Research on the International Space Station

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The emerging field of Translational Research aims to coalesce interdisciplinary findings from basic science for biomedical applications. To complement spaceflight research using human subjects, translational studies can be designed to address aspects of space-related human health risks and help develop countermeasures to prevent or mitigate them, with therapeutical benefits for analogous conditions experienced on Earth. Translational research with cells and model organisms is being conducted onboard the International Space Station (ISS) in connection with various human systems impacted by spaceflight, such as the cardiovascular, musculoskeletal, and immune systems. Examples of recent cell-based translational investigations on the ISS include the following. The JAXA investigation Cell Mechanosensing seeks to identify gravity sensors in skeletal muscle cells to develop muscle atrophy countermeasures by analyzing tension fluctuations in the plasma membrane, which changes the expression of key proteins and genes. Earth applications of this study include therapeutic approaches for some forms of muscular dystrophy, which appear to parallel aspects of muscle wasting in space. Spheroids is an ESA investigation examining the system of endothelial cells lining the inner surface of all blood vessels in terms of vessel formation, cellular proliferation, and programmed cell death, because injury to the endothelium has been implicated as underpinning various cardiovascular and musculoskeletal problems arising during spaceflight. Since endothelial cells are involved in the functional integrity of the vascular wall, this research has applications to Earth diseases such as atherosclerosis, diabetes, and hypertension. The goal of the T-Cell Activation in Aging NASA investigation is to understand human immune system depression in microgravity by identifying gene expression patterns of candidate molecular regulators, which will provide further insight into factors that may play a critical role in immune function loss during aging. In addition, Omics investigations with cells have synergistic applications ranging from the evaluation of pharmacological countermeasures to drug discovery. Thus, cell-based translational research onboard the ISS is bidirectionally bridging cutting-edge cellular and molecular approaches with space bioastronautics and human health methodologies on Earth.